

**REMARKS**

Favorable reconsideration is respectfully requested in view of the following remarks.

**I. CLAIM STATUS**

As correctly indicated in the Office Action Summary, claims 1-7 are pending in this application, and stand rejected.

**II. REJECTION UNDER 35 U.S.C. § 103**

Claims 1-7 stand rejected under 35 U.S.C. § 103(a), as allegedly obvious over Aikawa et al., EP0704413-A2. See Office Action, page 3.

Applicants respectfully traverse this rejection for the following reasons.

Aikawa fails to render the claimed invention obvious, because the reference fails to teach and/or suggest each and every element of the claimed invention, namely, the claimed burr and dimple heights. Also, Aikawa lacks a suggestion to modify his manufacturing process to arrive at the burr and dimple heights of the claimed ceramic sheet.

To establish obviousness, three criteria must be met. First, the prior art references must teach or suggest each and every element of the claimed invention. Second, there must be some suggestion or motivation in the references to either modify or combine the reference teachings to arrive at the claimed invention. Third, the prior art must provide a reasonable expectation of success.

In the present case, claim 1 requires that the claimed ceramic sheet has a thickness of 50  $\mu\text{m}$  or more; a burr height on the periphery of the sheet of  $\pm 100 \mu\text{m}$  or less, and/or a dimple height on the surface of the sheet of 100  $\mu\text{m}$  or less.

Aikawa does not teach nor suggest a ceramic sheet or substrate having the claimed burr and dimple heights. Instead, according to the Examiner, it would have been obvious that a maximum surface roughness of less than 0.8  $\mu\text{m}$  would limit the burr and/or dimple heights to less than 100  $\mu\text{m}$ , because Aikawa teaches the desirability of a flat surface. In making this assertion, it seems that the Examiner considers the burr/dimple irregularities of the present invention to be the

same as the waviness and warp defects of Aikawa. However, they are not the same. The burr/dimple of the present invention differ from the waviness and warp of Aikawa.

The Specification at page 9, lines 14-25 defines burr height and dimple height. Burr height means the difference in heights between the maximum point and the minimum point of the sheet in an area ranging from the peripheral edge of the sheet to 3 mm inside the edge. Dimple height means a protrusion or a depression locally formed on the surface of a sheet.

By contrast, Aikawa teaches that waviness and warp mean continuously occurring waves. Waves differ structurally from protrusions/depressions. Thus, the burr/dimple of the present invention differ in structure and shape from the waviness and warp of Aikawa. Accordingly, Aikawa fails to teach the burr/dimple height of the present invention.

Furthermore, as discussed at page 2, lines 11-19 of the Specification and at page 2, lines 48-49 of Aikawa, if a ceramic sheet has warp and waviness and other irregularities, the stacking-induced load and thermal stress concentrate at the irregularities. This invites cracking and breakage of the sheet. Consequently, even if the ceramic sheets have minimized warp and waviness as disclosed in Aikawa, cracking and breakage still occurs due to the degree of the stacking-induced load or thermal stress. In other words, Aikawa's teaching of controlling the waviness and warp does not suppress the cracks and breakages of the sheet caused by burr/dimple irregularities. This contrasts with the present invention which provides a ceramic sheet which suppresses the cracking and breakage by maintaining the values of burr and dimple within the claimed ranges.

In support of this position, a Declaration under 37 C.F.R. § 1.132 by Norizazu Aikawa (i.e., the current inventor and the author of Aikawa) is attached which discusses an Experimental Report comparing the ceramic sheets of the present invention with those of Aikawa. The results demonstrate that maintaining the values of waviness, warp, and Rmax of the sheet within the ranges defined by Aikawa cannot prevent cracking under load-applying test at high temperature unless the values of burr and dimple are maintained within the range defined by the present invention.

The Aikawa Declaration further shows that the load-applying testing of Aikawa was conducted at room temperature. See Aikawa, Table 1 of the Examples. This differs from the

claimed invention, because Aikawa does not contemplate load-applying testing conducted at high temperatures as done in the present invention.

Thus, in contrast to the sheets disclosed in Aikawa, the claimed ceramic sheet of the present invention exhibits less cracking/breakage even when a large stacking-induced load or thermal stress is applied than the prior art sheet. See also Specification, page 9, lines 1-5. The present invention accomplishes this effect by controlling the burr/dimple height of the sheet. Thus, the Aikawa Declaration demonstrates that the claimed ceramic sheets differ from the those in Aikawa, and in fact, exhibits superior properties over the prior art sheets.

Furthermore, in contrast to the position taken in the Office Action, the calculation of surface roughness is not suggestive for the claimed invention. The surface roughness disclosed in Aikawa is not the same as burr/dimple of the claimed invention. The surface roughness (Rmax) of Aikawa is calculated from the sheet surface value obtained by filtering a sheet shape factor depicting a larger wave length than a certain wave length level as defined in ASME B46, 1-995. As such, the value of the surface roughness does not reflect burr/dimple height, waviness and warp. Since surface roughness does not reflect burr/dimple heights, a maximum surface roughness of less than 0.8  $\mu\text{m}$  is not suggestive of the claimed burr and/or dimple heights of less than 100  $\mu\text{m}$ . See page 3, lines 13-17 of the Specification.

Also, the burr and dimple of the present invention are distortions of the sheet itself, whereas the surface roughness in Aikawa is the convex on the sheet surface. In other words, the present invention discloses a macro level defect of the sheet itself which is caused by the sheet forming process, whereas Aikawa discloses a micro level defect in the sheet surface caused by the raw material.

Based on these differences in structure and shape, Aikawa cannot be said to teach and/or suggest each and every element of the claimed ceramic sheet.

Furthermore, in addition to the differences in shape between the burr/dimple of the claimed invention and the waviness/warp of the prior art, the method for producing the claimed ceramic sheet differs from that of Aikawa.

In the present invention, the burr is formed by punching a ceramic sheet into predetermined configurations. Specification, page 23, lines 2-7. The burr is suppressed by

optimizing the punching step (pages 16, line 20 to page 17, line 2 and examples) and the dimple is suppressed by using powders when sintering the sheet (page 25, line 14 to page 26, line 1). Also, the dimple is formed by the non-uniformity of baking or the uneven sliding between the green sheet surface and a porous sheet during the shrinkage accompanied by the sintering of the sheet. Specification, page 23, lines 2-7.

By contrast, in Aikawa, the waviness and warp of the sheet is formed by the unevenness of the thermal condition during the sintering. See, Aikawa, background section. Aikawa teaches that the waviness and warp are suppressed by sintering the sheet by interposing with green sheets. Aikawa, page 7, lines 35-50. However, as discussed above, even minimizing warp and waviness may not prevent cracking and breakage due to stacking-induced load or thermal stress. Thus, as discussed above, Aikawa's method of controlling waviness/warp cannot solve the problem associated with the cracks and breakage caused by dimple/burr.

Aikawa further discloses a porous sheet having a larger area than that of a green sheet and a bulk density corresponding to 30-85% of the theoretical density. Aikawa also discloses a shrinkage rate caused by heating up to the calcining temperature of the green sheet which is 5% or less as effective for suppressing the waviness and warp. Aikawa, page 7, lines 35-50.

However, the Specification at page 24, lines 1-5 teaches that the porous sheet is insufficient to limit the burr and dimple heights of the ceramic sheet. In other words, the sheet of Aikawa is insufficient for suppressing the waviness and dimple height. Specification, page 23, line 14 to page 25, line 13. Instead, to obtain the sheet of the present invention having suppressed dimple height, it is important to interpose powder between the contact surfaces of the porous sheet and the green sheet. Specification, page 25, line 14 to page 26, line 1. The effect of interposing the powder is shown in the example of the Specification. Aikawa fails to disclose the effect and reasons for doing so. Aikawa does not disclose using the small particles between the ceramic green sheet and the porous sheet as disclosed in the present invention. Nor does Aikawa teach and/or suggest optimizing the punching step.

In view of the above, it is evident that Aikawa only discloses a method for controlling the waviness and warp height by adjusting the baking step. This method differs from the process

utilized in the present invention, and it produces ceramic sheets that differ from the claimed sheets.

In sum, Aikawa does not teach the method utilized of the claimed invention for controlling dimple/burr. Consequently, Applicants and Aikawa disclose different methods for solving different problems. For these reasons, Aikawa fails to teach and/or suggest the specific condition for suppressing the cracking and breaking brought by dimple or burr by maintaining the burr an dimple within the claimed range. Specification, page 3, lines 17-20. Aikawa also lacks a suggestion to modify his manufacturing process to arrive at the burr and dimple heights of the claimed ceramic sheet.

Therefore, Aikawa fails to teach and/or suggest each and every element of the claimed invention, and Aikawa lacks the requisite suggestion and/or motivation to combine/modify their teachings to arrive at the claimed invention. Accordingly, Aikawa cannot render the claimed invention obvious. Thus, the rejection of claims 1-7 under 35 U.S.C. § 103(a) is untenable and should be withdrawn.

#### CONCLUSION

In view of the foregoing amendments and remarks, the present application is now in condition for allowance and early notice to that effect is hereby requested.

If it is determined that the application is not in condition for allowance, the Examiner is invited to telephone the undersigned attorney at the number below to expedite prosecution of the present application.

Respectfully submitted,

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April 21, 2004

Attorney Docket No.: 2000\_0776A  
Application No.: 09/597,763  
April 21, 2004

**ATTACHMENT TO REPLY:**

Declaration under 37 C.F.R. § 1.132 by Norizazu Aikawa